OCCUPATIONAL EXPERIENCES WITH PESTICIDES IN CALIFORNIA*

By

Irma West, M.D.
Bureau of Occupational Health
State of California Department of Public Health

In California we are somewhat proud of the fact that we have a body of factual data about human effects from pesticides and other agricultural chemicals for one segment of the population, the 80% of the workforce covered by the Workmen's Compensation Law. I would like to summarize this experience first and then discuss some of the more pressing requirements for improving occupational safety in the use of pesticides in California.

I

MORBIDITY Data about nonfatal disease attributed to pesticides are available routinely through the Doctor's First Report of Work Injury.** The number of these reports describing occupational disease from pesticides and other agricultural chemicals has doubled since 1954, and has ranged from 800 to 1,100 reports annually since 1958 (see Table III and Table IV). The highest number were reported in 1959. Although there was an encouraging decrease in reported cases during 1960, 1961, and 1962 it appears that there will be an increase again in 1963. Most of the reports come from agriculture, which has the highest occupational disease rate of any industry in California. About one-half of these 800 to 1,100 reports concern skin desease and about one-third, systemic poisoning from chemicals. The phosphate ester pesticides, parathion, Phosdrin, and Thimet, account for most of the systemic poisoning cases.

LIMITATIONS OF CALIFORNIA'S SURVEILLANCE OF OCCUPATIONAL DISEASE FROM PESTICIDES

Because reports of occupational disease are not received from about one-third of the agricultural workers who are self-employed, data on occupational disease from pesticides and other agricultural chemicals are understated. In addition, the amounts of the various major categories of

*Presented at the International Short Course on the Occupational Aspects of Pesticides, Oklahoma Center for Continuing Education, Norman, Oklahoma, November 20, 21, 22, 1963.

**Each physician who attends an injured employee and each employer of such a worker is required by Section 6407 of the California Labor Code to file a report with the State Department of Industrial Relations when disability lasts beyond the day of injury or requires medical service other than ordinary first-aid treatment. By definition, work injury includes occupational disease. Under an interagency agreement with the State Department of Industrial Relations, the California State Department of Public Health through its Bureau of Occupational Health, reviews and analyzes those doctors' reports (Doctor's First Report of Work Injury) which concern occupational disease. Reports are received only for the 80% of employed persons in California covered by the California Workmen's Compensation Law. In the 20% excluded are federal employees, maritime workers, railroad workers in interstate commerce and self-employed. Since 1959, California farmers have been required to cover their employees with compensation insurance. Even before this was required, over 90% of the farm workers in California were covered by workmen's compensation. Self-employed farmers, about one-third of the farm workers, however are excluded.

pesticides used in California annually are unknown. Also unknown are the number of California workers who actually work with or are exposed to these chemicals. We do know that the acreage treated for pest control increases each year (in 1962 it was 12 million acres, about half of it treated by aircraft) and that the number of brand name pesticide products registered for sale in California also increases annually (15,693 for 1961-'62 fiscal year).

Completeness of reporting is stimulated by the reporting mechanism wherein the Doctor's First Report of Work Injury is not only a legal requirement, but is one of the official forms which must be completed to collect fees. Only definite and usually acute conditions are reported. Rarely is a long-term or delayed condition the subject of one of these reports. Reports are received about a month after the condition occurred and are therefore not useful for immediate investigation.

MORTALITY FROM PESTICIDES

Californi uses about 20% of the nation's pesticides, but account for approximately 7% of the nation's deaths reported due to pesticides. Although nationally only about 13 percent of the pesticidesare used outside agriculture, in California half of the deaths from pesticides result from exposure outside agriculture. Beginning in 1951, death certificates listing pesticides as the cause of death have been reviewed and tabulated. An average of two in workers, and an average of two in the remainder of the population. In about half of the deaths, arsenic was the cause. However, among workers the potent phosphate esters and methyl bromide account for most of the fatalities.

Occupational deaths have been investigated for further information whenever possible. Findings indicate that deaths from pesticides, particularly the phosphate esters, could be missed if a history of exposure is overlooked and appropriate chemical tests are omitted. Our information also points up that workers and employers who are not prepared to handle hazardous chemicals are doing so regularly.

Among California children under five years about 25 percent of the fatal poisoning have been attributed to pesticides. In about 10 percent of the cases where small children receive emergency treatment for ingestion of noxious substances, the substance is a pesticide.

It is of interest to note that in the past decade there have been three entirely different groups of pesticides primarily involved in fatal effects upon humans and wildlife: for children it has been arsenic, for workers phosphate esters, and for wildlife the chlorinated hydrocarbons.

CASES OF OCCUPATIONAL DISEASE DUE TO PESTICIDES

Case 1. A recent occupational fatality from a pesticide resulted indirectly from parathion poisoning. A young sprayer was found dead in the field in the tractor with which he had been pulling his spray rig. He had been pouring and mixing the concentrate into the spray rig tank. In the process he contaminated

his gloves inside and out. He rested his gloved hands on his trousers as he pulled the rig to apply the spray. Parathion was absorbed through the skin of his hands and thighs. Apparently he began to vomit, an early symptom of parathion poisoning. He could not remove his respirator and he aspirated the vomitus. The diagnosis of poisoning was confirmed by post-mortem cholinesterase tests. Key safety rules for handling parathion were not followed. The worker was obviously unaware of how to protect himself.

Case 2. A young man came to work as a swamper for an agricultural aircraft operator and the first day was put to work steam cleaning and washing a crop-dusting aircraft. It was reported that he was not informed of any hazard or was he given any protective clothing or equipment. His clothing was observed to have been wet while he was working. In the early afternoon he complained of not feeling well. His employer gave him two atropine tablets and the swamper returned to work. Not long afterwards he was found unconscious. He was admitted to the hospital and died several hours later. Apparently the aircraft he was cleaning had been used to make several applications of one of the highly toxic phosphate ester pesticides. The diagnosis of phosphate ester pesticide poisoning was confirmed by post-mortem cholinesterase tests.

Case 3. Beginning in 1949 there have been at least six sizable outbreaks of parathion poisoning among fruit pickers. The fruits involved were oranges, peaches, pears, grapefruit, grapes, and olives. In 1959 about 275 orange pickers were poisoned in a series of outbreaks. The interval between application of pesticides and the harvest of edible crops is subject to state regulations and is predicated on the time when the pesticide residue on the edigble crop will be below legal tolerance (1 ppm for Parathion) and thus safe for market. It had been assumed that by the time parathion was below tolerance on the crop it would have declined sufficiently to make the orchards safe for the workers. This assumption was obviously incorrect . In August of 1963 over 90 peach pickers became sufficiently ill with parathion poisiong to seek medical attention. There were about 6000 pickers in the area of whom about 70 apparently well pickers were tested at random during the outbreak. Fifty percent showed significant reduction of red cell and plasma cholinesterase levels but were either asymptomatic or had not sought medical attention for their symptoms. Although most of the cases were mild or moderate, about one-third were hospitalized and there was one death. Leaf samples, fruit samples, and spray schedules were obtained both in the orchards involved in the outbreak as well as in orchards not involved. It became obvious that the unusually heavy spraying with parathion during the spring and summer to combat the oriental fruit moth had resulted in a have deposit on the leaves. In all cases spray schedules showed that over two weeks had elapsed between the last parathion application and picking. Peaches were below 1 ppm of parathion. During

the growing season as many as 7 parathion applications were made in contrast to the usual two or three. Because of a greater suface area on the leaves, they had collected by weight more pesticide than the fruit. This study confirmed the contention of earlier investigators* that exposure from the leaves of the heavy foilage was the source of the parathion. However, the heavy spraying schedules were the clue to why there was excessive residue on the leaves. Work is continuing, particularly with reference to the degradation products of parathion, their stability, and if they played a role in this episode. The final report should be available soon.

Case 4. Twenty-five laborers planting cotton in the hot San Joaquin Valley became suddenly ill with nausea, headaches, giddiness, blurred vision, sweating, and other symptoms typical of phosphate ester poisoning. They had been unloading bags of Thimet-treated cotton seeds from trucks, loading the machinery which plants the seeds, and piling and burning the empty bags. No washing facilities or protective clothing were available to these workers. Protective clothing to prevent skin absorption of this highly toxic pesticide must be air cooled to be feasible in 105° weather. Here is a situation which calls for industrial hygiene engineering controls to alter the work processes to make feasible a safer planting procedure.

Case 5. A 16-year-old and a 21-year-old farm laborer were hired to apply a phosphate ester pesticide and sulphur to strawberries. The workers used knapsack dusters, starting work at 7:30 a.m. At noon the 21-year-old worker became ill and was reported to have remained at the side of the field in his car vomiting. After a while he felt better and drove home. (Fortunately he didn't have an auto accident. Workers with phosphate ester poisioning are poor risks with any moving machinery.) The 16-year-old worked until 4:30 p.m. Later in the evening he complained of weakness and giddiness and was taken to a physician's office. The boy's clothing was reported to have been covered with sulphur. The physician called the Poison Information Center for information about sulphur. The boy was sent home with a prescription. At 9:30 p.m. the boy became worse and the physician was called again. He suggested that the boy be brought to the local hospital. This time the label from the pesticide container was brought with the patient. The boy was again sent home although he was unable to walk. At 7:30 a.m. the boy was found moribund in his bed, still in his contaminated work clothing. He died in the ambulance en route to the hospital. Death due to phosphate ester poisioning was confirmed by post-mortem cholinesterase tests.

---

*Quinby, G.E. and Lemmon, A.B.: Parathion residues as a cause of poisoning in crop workers. J.A.M.A., 166:740, 1958.

The 21-year-old workers, although asymptomatic, reported the next day for a cholinesterase test which confirmed that he also had been poisoned by a phosphate ester chemical. He had not worked with phosphate ester pesticides before. The 16-year-old had applied the same pesticide on one occasion two months before.

There were a number of errors committed in the series of events leading to this death: The permit to purchase and apply the pesticide had expired so that it was purchased and applied illegally. The highly toxic phosphate ester was applied by hand duster, a primitive and entirely unsafe method of application. The container label was not read by anyone until after the second illness. No advance arrangements were made with a physician for prompt, adequate care for an emergency. The two workers were not instructed about hazards and precautions for using the pesticide. They were not provided with protective clothing. No medical attention was sought for the worker who quit at noon because of illness and no medical examination was considered for the younger employee who kept on working. The victim was not told to bathe, wash his hair and change into clean clothes after work. When the boy was taken to a physician no one could provide any information about the pesticide which the workers had applied.

On first visit, the physician released the victim as only mildly ill without ruling out serious poisoning . He should have insisted on seeing a label from the pesticide container. On second visit, the physician was furnished with the label but he did not follow the medical treatment recommended. He was apparently confused by the large dose of atropine prescribed on the medical treatment statements on the label and instead gave the boy a prescription for the first-aid dose also on the label. He did not acall a consultant or the Poison Information Center for information about the pesticide mixture listed on the label. The boy was not kept under observation for 48 hours. He was not decontaminated and no cholinesterase determination was made.

The supplier of the pesticide did not check the number of the permit given by the purchaser to assure that the permit was valid. The product was also misbranded, it contained 2 to 4 times the phosphate ester pesticide specified on the label. The medical recommendations on the label can confuse an inexperienced physician. The "first-aid" instructions for atropine tablets need reevaluation. I know of three deaths in which these instructions have proved detrimental, and I know of no benefit from them in a emergency.

This case is something of a classic in that just about every error it was possible to commit occurred, and avoidance of any one of the more serious errors could easily have saved the boy.

Case 6. For several days a young employee of a pest control operator had been fumigating a large housing project with lindane. After completing work on over a hundred units he

quit work early because he wasn't feeling well and drove toward home. He experienced a convulsion which resulted in a traffic accident. His driver's license was suspended pending investigation. This worker's physician was sufficiently astute to consider the occupational exposure. He concluded that the patient's seizure was due to acute lindane poisoning. The worker has had not recurrence of seizures in the intervening 6 years.

Case 7. A 45-year-old laborer worked for about six days mixing a solution of pentachlorophenol in diesel oil for use as fungicide. From a thirty-gallon drum he measured and poured a forty percent concentrate into a five-gallon bucket. The last afternoon he worked the spigot came off the drum into the bucket of concentrate. He reached in with his bare hand and retrieved it. He did not wash himself and worked the rest of the day. The next day, late in the afternoon, a fellow worker found the laborer lying on the floor of his quarters complaining of pain in his chest and feeling very warm. He was very thirsty and called for water repeatedly, drinking four soup bowls full in several minutes time. He was taken by ambulance to the hospital. The doctors who attended the laborer was unable to determine what chemical he had been using and it was not until very shortly before the worker's death the next morning that the chemicals was identified. The worker died from his high fever. (Pentachlorophenol is a metabolic stimulant, increasing body temperature.)

Case 8. A young Mexican laborer was employed to process edible nuts. When the nuts became infested it was customary to fumigate them under tarps with methyl bromide. This employee had been assisting with these operations. He came ill rather suddenly at home and died within a few hours after being admitted to the hospital. The cause of death could not be determined until the coroner's office sent specimens to the health department laboratory to see if any usual chemicals might be involved. Subsequent investigations revealed the work history of repeated exposure to methyl bromide. Methyl bromide is second to parathion as a cause of occupational deaths from pesticides in California.

II

What is needed in order to deal more effectively with occupational health problems arising out of the use of pesticides?

MORE RESEARCH Research into the occurrence, significance, and prevention of the undesirable side effects arising out of the use of pesticides is considerably behind research into the efficacy and specificity of pesticides. Pesticide exposure at work, in the home and garden, and the effects of pesticides on wildlife and other desirable aspects of the environment have received little research attention. Although the Public Health Service through its Toxicology Section, has produced research reports of great value in the occu-

pational deaths from pesticides in California.

II

What is needed in order to deal more effectively with occupational health problems arising out of the use of pesticides?

MORE RESEARCH Research into the occurrence, significance, and prevention of the undesirable side effects arising out of the use of pesticides is considerably behind research into the efficacy and specificity of pesticides. Pesticide exposure at work, in the home and garden, and the effects of pesticides on wildlife and other desirable aspects of the environment have received little research attention. Although the Public Health Service through its Toxicology Section, has produced research reports of great value in the occupational health area, a lot more is needed, particularly involving a research personnel trained in industrial hygiene and industrial medicine.

Only one area has received considerable research attention and that is pesticide residue on foods. Perhaps one of the problems has been preoccupation with food residue. Important as it is it is not only consideration. Yet in the registration of pesticides, research information concerned with food residue is the major requirement. These data are often quite inadequate for other health and safety purposes.

Research needs in occupational health can be divided roughly into two parts: that part needed to reply to a large backlog of unanswered questions regarding the protection of workers exposed to pesticides already widely used, and that part which deals with continuing research for every new agricultural chemical in its development and experimental stages so that worker health information will be obtained routinely as a requirement for federal and state registration for any hazardous pesticide to be used by workers.

Examples of the backlog of unanswered questions include: What is a safe parathion spray schedule and the safe preharvest interval before pickers and others can safely enter to pick the various kinds of heavy foilage fruit crops? How should agricultural aircraft and ground spraying and mixing equipment be designed to prevent exposure to toxic agricultural chemicals among pilots, helpers and sprayers? Should more attention be given to the physical states of toxic pesticides so that air and ground spraying or dusting minimizes human exposures? Should more attention be directed toward packaging pesticides to reduce workers' exposure? What are the minimum standards for medical and safety supervision for first aid and medical care? Can practical protective clothing and washing facilities be developed and used by field workers in agriculture to protect themselves against toxic chemicals? What are the minimum standards of knowledge and education necessary in order to

to work safely with toxic agricultural chemicals? What should be the legal requirements to protect workers and how should these requirements be enforced? Can a more simple and practical screening test for cholinesterase activity be devised for surveillance of workers using the more toxic organic phosphate? Can practical laboratory tests be devised for surveillance of workers exposed to other important toxic pesticides?

CLOSER REGULATION OF PESTICIDE USERS

Using a highly toxic pesticide properly requires intelligence, technical knowledge, and moral responsibility. That one or more of these ingredients has been too often missing is evidence in most of the reports of poisoning we have received and in the investigations conducted by our Bureau of Occupational Health.

Although California regulates more closely than any other state the use of hazardous pesticides, there are some additional steps which need to be taken. The individual responsible for using a hazardous pesticide must be more closely regulated. In agriculture it is the farm laborer who experiences most of the occupational disease from pesticides. Because of inadequate education, language problems, migratory status, substandard health, and poor hygiene, these workers are the least likely of any group to be able to work safely with farm chemicals. Either elaborate and constant supervision must be provided, or users of hazardous pesticides should be restricted to persons who can demonstrate their ability to work safely with them (perhaps in the same way that users of radioactive isotopes must demonstrate their ability before receiving these materials).

Food handlers are often required by regulations to take a course in how to protect themselves and the public in the course of their work. It would seem no less important to provide and require such courses for all pesticide handlers in agriculture, and other industries as well. Some pest control operators are required to have varying degrees of this type of knowledge. However we have found that it may be his untrained employee who actually makes the pesticide applications. It should be recognized that responsible application of pesticides is a technical operation. It requires intelligence, specific education, and training. Without them no one is competent, yet illiterate and mentally deficient* persons are not barred from applying the most toxic pesticides in many areas of the country.

MORE INDUSTRIAL HYGIENE AND OCCUPATIONAL MEDICINE ON THE FARM

Concepts in industrial hygiene and industrial medicine commonly used for many years in other industries have not been employed or adapted to the agricultural setting. The rapidly advancing technological changes have left agriculture behind in dealing with its health and safety problems. Such commonplace needs as clean drinking water, wash water and sanitary facilities are

*Arterberry, J.D., Et al: Potentiation of Phosphorous Insecticides by Phenothiazine Derivatives, J.A.M.A., 182:848, November 24, 1962.

are rarely available in the fields, and notably deficient in many of the living quarters of farm laborers. These deficiencies account in part for the fact that in California agriculture the occupational disease rate is 50 percent higher than the industry in second place and the disabling work injury rate is surpassed only by construction and metal mining.

Medical supervision of workers exposed to toxic chemicals is more urgent on the farm than in a conventional industrial setting. When environmental control is more difficult, as in agriculture, the more critical the medical program because injury and disease are getting closer to the workers who must be examined and treated more frequently. However, many physicians in farming areas are not interested or prepared to provide industrial medical services, but one step in this direction has been taken in California. When the Agricultural Safety Orders of the State Industrial Safety Board were complete in 1961, they included a requirement for medical supervision of all agricultural workers regularly applying the toxic group of organic phosphates. In addition to regular cholinesterase tests which can in many instances detect excessive exposure before illness occurs, each employer must arrange with a physician beforehand to deal with emergency poisonings. This procedure is more likely to place emergencies in the hands of physicians prepared to treat them adequately and has improved considerably medical involvement in the pesticide problem. (Only for workers regularly using these pesticides and for those exposed to ionizing radiation, is medical supervision required in California.)

Physicians are often critical because they were not properly prepared to recognize and treat a pesticide poisioning emergency. Several victims of phosphate ester poisoning in California could have been saved if the attending physician had provided adequate treatment. There is a compelling need to bring this information to physicians expected to care for casualties. For many of these chemicals there has been little developed in the way of practical laboratory tests to assist the physicians in the diagnosis of poisoning. Such tests should be developed before the use of pesticides likely to cause poisoning, and should be a requirement for federal and state registration of such pesticides.

MORE MONEY FOR HEALTH

We need to realize that more money and more technical skills from the health field should be invested in surveillance programs, in research, and in control programs for safety in the use of pesticides. I say "invest" because it takes less money to prevent the undesirable side effects than it does to pay for them after they occur. For example, the fruit picker parathion poisoning problem has cost many thousands of dollars -much more than the cost of the research which should have been carried out long ago to determine a safe spray schedule and preharvest interval for pickers. One of the reasons occupational health and other safety problems have been overlooked in pesticide development has been that those in charge are technically qualified in fields other than health. Today's technology is too complex to leave decisions entirely in the hands of persons trained in one

or two technical areas. In pesticides, skills related to agriculture, entomology, human toxicology, and animal and plant toxicology, public health, industrial hygiene, occupational medicine, fish and wildlife management and conservation are just a few of the technical skills needed in the development of pesticides so that all bases are covered in research and in control programs for safer use of pesticides.

It seems strange to me that a great deal of research money is allocated to investigate relatively obscure diseases involving few people or older people while at the same time we damage wholesale relatively healthy young specimens of w the working population because we overlook research into man-made health and safety problems arising from tools of our industry and technology. Pesticides are just an example and perhaps not the best one (traffic accidents are the best example). However pesticides are a relatively new and growing hazard. We still have the time and a great opportunity to build more and improved health and safety considerations into their development.

#